WHAT IS CLAIMED IS:

1. An apparatus for converting hydrocarbon fuel into a hydrogen rich gas comprising:
   a manifold for mixing the hydrocarbon fuel with an oxygen containing gas to give a fuel mixture;
   an autothermal reactor including a catalyst for reacting the fuel mixture under autothermal reforming conditions to give a hydrogen containing gaseous mixture;
   a water gas shift reactor including a catalyst for reacting the hydrogen containing gaseous mixture under water gas shift reaction conditions to give an intermediate hydrogen containing gaseous mixture with a substantially reduced carbon monoxide content; and
   a selective oxidation reactor including a catalyst for reacting the intermediate hydrogen containing gaseous mixture under selective oxidation reaction conditions to produce the hydrogen rich gas.

2. The apparatus according to claim 1, further comprising a heat exchanger for heating the hydrocarbon fuel into a heated hydrocarbon fuel, wherein the heated hydrocarbon fuel becomes the hydrocarbon fuel feed to the manifold.

3. The apparatus according to claim 2, further comprising a desulfurization reactor including a catalyst for reacting the heated hydrocarbon fuel under desulfurization conditions to produce a substantially desulfurized hydrocarbon fuel, wherein the substantially desulfurized hydrocarbon fuel becomes the hydrocarbon fuel feed to the manifold.

4. The apparatus according to claim 1, further comprising a heat exchanger for heating the fuel mixture to produce a heated fuel mixture, wherein the heated fuel mixture becomes the fuel mixture feed to the autothermal reactor.

5. The apparatus according to claim 4, further comprising a desulfurization reactor including a catalyst for reacting the hydrogen containing gaseous mixture under

desulfurization conditions to produce a substantially desulfurized hydrogen containing gaseous mixture, wherein the substantially desulfurized hydrogen containing gaseous mixture becomes the hydrogen containing gaseous mixture feed to the water gas shift reactor.

6. The apparatus according to claim 1, wherein the hydrocarbon fuel is selected from the group consisting of natural gas, methane, ethane, propane, butane, liquefied petroleum gas, naphtha, gasoline, kerosene, diesel, methanol, ethanol, propanol, and combinations thereof.

7. The apparatus according to claim 1, wherein the hydrogen rich gas contains less than 50 ppm of carbon monoxide.

8. The apparatus according to claim 1, further comprising an anode tail gas oxidizer including a catalyst for reacting the unconverted hydrogen from a fuel cell under oxidation conditions to create a hot anode tail gas oxidizer effluent.

9. The apparatus according to claim 8, wherein the hot anode tail gas oxidizer effluent is heat integrated with the apparatus.

10. An apparatus for converting hydrocarbon fuel into a hydrogen rich gas comprising:

a first heat exchanger for heating the hydrocarbon fuel to produce a heated hydrocarbon fuel;

a first desulfurization reactor for reacting the heated hydrocarbon fuel to produce a substantially desulfurized hydrocarbon fuel;

a manifold for mixing the substantially desulfurized hydrocarbon fuel with an oxygen containing gas to produce a fuel mixture;

a second heat exchanger for heating the fuel mixture to produce a heated fuel mixture;

an autothermal reactor including a catalyst for reacting the heated fuel mixture to produce a first hydrogen containing gaseous mixture;

a second desulfurization reactor for reacting the first hydrogen containing gaseous mixture to produce a second hydrogen containing gaseous mixture that is substantially desulfurized;

a water gas shift reactor for reacting the second hydrogen containing gaseous mixture to produce a third hydrogen containing gaseous mixture with a substantially decreased carbon monoxide content; and

a selective oxidation reactor for reacting the third hydrogen containing gaseous mixture to produce the hydrogen rich gas; and

11. The apparatus according to claim 10, wherein the hydrocarbon fuel is selected from the group consisting of natural gas, methane, ethane, propane, butane, liquefied petroleum gas, naphtha, gasoline, kerosene, diesel, methanol, ethanol, propanol, and combinations thereof.

12. The apparatus according to claim 10, wherein the hydrogen rich gas contains less than 50 ppm of carbon monoxide.

13. The apparatus according to claim 10, further comprising an anode tail gas oxidizer including a catalyst for reacting the unconverted hydrogen from a fuel cell under oxidation conditions to create a hot anode tail gas oxidizer effluent.

14. The apparatus according to claim 13, wherein the hot anode tail gas oxidizer effluent is heat integrated with the apparatus.

15. A method for converting hydrocarbon fuel into a hydrogen rich gas, comprising:

mixing the hydrocarbon fuel with an oxygen containing gas to produce a fuel mixture;

reacting the fuel mixture in the presence of a catalyst under autothermal reforming reaction conditions to produce a hydrogen containing gaseous mixture;

reacting the hydrogen containing gaseous mixture in the presence of a catalyst under water gas shift reaction conditions to produce an intermediate hydrogen

containing gaseous mixture with a substantially reduced carbon monoxide content; and

reacting the intermediate hydrogen containing gaseous mixture in the presence of a catalyst under selective oxidation conditions to produce the hydrogen rich gas.

16. The method according to claim 15 further comprising heating the hydrocarbon fuel to produce a heated hydrocarbon fuel, wherein the heated hydrocarbon fuel becomes the hydrocarbon fuel feed to the mixing step.

17.The method according to claim 16 further comprising reacting the heated hydrocarbon fuel in the presence of a catalyst under desulfurization conditions to produce a substantially desulfurized hydrocarbon fuel, wherein the substantially desulfurized hydrocarbon fuel becomes the hydrocarbon fuel feed to the mixing step in a manifold.

18.The method according to claim 15, further comprising heating the fuel mixture to produce a heated fuel mixture, wherein the heated fuel mixture becomes the fuel mixture feed to the first reaction step.

19.The method according to claim 15, further comprising reacting the hydrogen containing gaseous mixture in the presence of a catalyst under desulfurization reaction conditions to produce a substantially desulfurized hydrogen containing gaseous mixture, wherein the substantially desulfurized hydrogen containing gaseous mixture becomes the hydrogen containing gaseous mixture feed to the second reaction step.

20. The method according to claim 15, wherein the hydrocarbon fuel is selected from the group consisting of natural gas, methane, ethane, propane, butane, liquefied petroleum gas, naphtha, gasoline, kerosene, diesel, methanol, ethanol, propanol, and combinations thereof.

21. The method according to claim 15, wherein the hydrogen rich gas contains less than 50 ppm of carbon monoxide.

22. The method according to claim 15, further comprising reacting anode tail gas from a fuel cell in the presence of a catalyst under oxidation conditions to produce a hot anode tail gas oxidizer effluent.

23. The method according to claim 22, wherein the hot anode tail gas oxidizer effluent preheats the hydrocarbon fuel.

24. A method for converting hydrocarbon fuel into a hydrogen rich gas, comprising:
heating the hydrocarbon fuel to produce a heated hydrocarbon fuel;
reacting the heated hydrocarbon fuel in the presence of a catalyst under desulfurization conditions to produce a substantially desulfurized hydrocarbon;
mixing the substantially desulfurized hydrocarbon with an oxygen containing gas to produce a fuel mixture;
heating the fuel mixture to produce a heated fuel mixture;
reacting the heated fuel mixture in the presence of a catalyst under auto thermal reforming conditions to produce a first hydrogen containing gaseous mixture;
reacting the first hydrogen containing gaseous mixture in the presence of a catalyst under desulfurization conditions to produce a second hydrogen containing gaseous mixture that is substantially desulfurized;
reacting the second hydrogen containing gaseous mixture with a catalyst under water gas shift reaction conditions to produce a third hydrogen containing gaseous mixture with a substantially reduced carbon monoxide content; and
reacting the third hydrogen containing gaseous mixture in the presence of a catalyst under selective oxidation reaction conditions of to produce the hydrogen rich gas.

25. The method according to claim 24, wherein the hydrocarbon fuel is selected from the group consisting of natural gas, methane, ethane, propane, butane, liquefied

petroleum gas, naphtha, gasoline, kerosene, diesel, methanol, ethanol, propanol, and combinations thereof.

26. The method according to claim 24, wherein the hydrogen rich gas contains less than 50 ppm of carbon monoxide.

27. The method according to claim 24, further comprising reacting anode tail gas from a fuel cell in the presence of a catalyst under oxidation conditions to produce a hot anode tail gas oxidizer effluent.

28. The method according to claim 27, wherein the hot anode tail gas oxidizer effluent preheats the hydrocarbon fuel.